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# FRACTURE MECHANICS BASED DESIGN OF SUPER-LOW ICE ADHESION SURFACES

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## Abstract

Ice accumulation poses significant challenges in industries such as aviation, transportation, and energy. While studies on suppressing ice nucleation by surface structuring and local confinement are highly desired, a realistic roadmap to icephobicity for many practical applications is perhaps to live with ice, but with the lowest possible ice adhesion. This talk explores the possibility of reducing ice adhesion by designing low-adhesion surfaces using fracture mechanics concept, inspired by biological systems and engineered solutions. By rationalizing crack initiation at multiple scales—nano (NACI), micro (MICI), and macro (MACI)—we demonstrate how to amplify interfacial crack driving forces and weaken ice–substrate bonding. A macro-crack initiator (MACI) mechanism is proposed, which significantly reduces ice adhesion by enhancing crack propagation at the ice-substrate interface across multiple length scales. The anisotropic ice adhesion behavior of Arctic salmon skin is also demonstrated, showing a reduction of up to 60% in ice adhesion when sheared along a specific direction. By leveraging biological insights and engineering strategies, we offer new possibilities for designing hard and durable anti-icing surfaces, opening new avenues for understanding and designing surfaces with tailored adhesion mechanics.

**Keywords**
Crack initiator; sequential rupture; ice adhesion; icephobicity

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